Crowded at the Summit: Emergent Infections and the Global Food Chain

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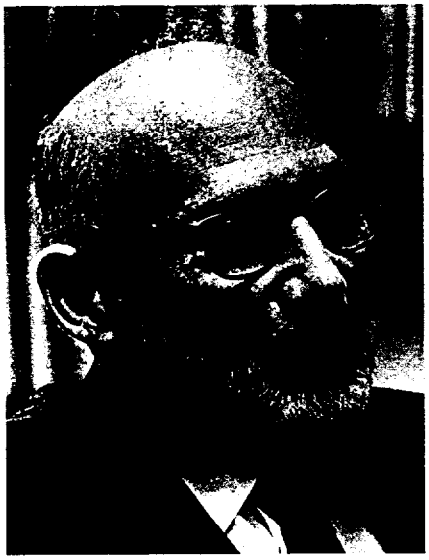
In 1900, infectious disease was the leading cause of mortality in the United States, accounting for at least 37% of deaths. By 1950, this had been mitigated to 6.8%, and again to 2.8% by 1989, with corresponding improvements in life expectancy. These numbers of course must be taken with a grain of salt, given the eventual preemptive role of infection in chronic illness and many disorders whose infectious etiology is still to be recognized. Further, the relative importance of sanitation, health education, and nutrition, in contrast to medical interventions like immunization and antibiotics, has remained in contentious debate. Regardless, this achievement is trumpeted as the conquest of infectious disease, indeed a glorious tribute to public health and medical science.

In consequence, health research since 1950 has ever more emphasized chronic constitutional afflictions like cancer, cardiovascular disease, and psychiatric disorder to the relative neglect of infection. Environmental anxieties are focused on radiation and chemical toxins rather than arthropod vectors and airborne contagion.

Our complacency over the triumph of the human over the microbial has been shaken by the human immunodeficiency virus (HIV) pandemic. In truth, the majority of the world's population has never been relieved of its load of malaria, tuberculosis, diarrheal disease, and a host of parasitoses. It has taken AIDS to provoke a new look at the threats to human health in the United States from infections recently thought to be conquered.



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These concerns were taken up by a recent study of the Institute of Medicine Task Force on Emergent Infections. The resulting report was the product of a broad collective effort which promptly reached unanimity that these threats urgently needed to be brought to public and policy attention. The report's recommendations had to do mainly with (i) the strengthening of disease (especially virus) surveillance systems globally, (ii) wider availability of existing vaccines and the removal of legal disincentives to the development of new ones, (iii) acceleration of the technology to enable vaccines against new strains to be developed on a time scale commensurate with the spread of infection, (iv) vector control, and (v) public education. Perhaps the most important message is that infection knows no national boundaries, and we will pay dearly if we ignore the smoldering of infection anywhere.

No single infectious agent is a unique target of concern. During the committee's deliberations, multiple-drug-resistant tuberculosis emerged as a major public health threat in New York City;

dare one say this was predictable from the time of its first appearance a few years ago in immunocompromised people with AIDS? Historically, the influenza of 1918 to 1919 was the most recent previous pandemic to have a major effect on U.S. mortality statistics. Many believe a recurrence of such a lethal reassortment strain, entering a now-naive human herd, is all but inevitable. At the moment, HIV is evolving towards greater serodiversity (potentially frustrating proposed vaccines) and occasional azidothymidine resistance. But its fundamental biological properties happily have not evolved towards easier spread; to the contrary, there are hints of the appearance of strains with a longer latent period or perhaps associated with very limited pathogenicity. On the other hand, simian virus strains have evolved with aggressive and acute lethality. There is no way to guarantee that the same cannot occur with HIV in the human population, and the potentials for genetic recombination with related lentiviruses have scarcely been thought about. A multitude of other zoonoses foster scary outbreaks and importations of Lassa, Marburg, and Ebola viruses. Changing vector distributions, ill heeded, open the way to a family of encephalitides.

Economic and technical advances confer many defenses against infection. Nevertheless, the sheer increase of the global population, its local density in conurbations, and the scale and ease of rapid transoceanic travel are discontinuities in the human condition that aggravate our vulnerability to emergent infections. Some of these are new genetic variants; many others are diseases all too common in their historic habitats which now have new opportunities to spread. Agricultural and residential encroachments on forested lands augment the risk of human contact with arborviruses and borreliae. Other vectors and pests accompany the movement of people and goods. And microbial populations have their own dynamic of evolutionary change connected with their rapid replication, vast numbers, and inherent instabilities—especially on the part of RNA viruses. That the human species has survived so well is a tribute to its evolution of biological immunity and a modest degree of intelligent self-defense.

The human occupation of planet Earth has left us with a conceit that our species is at the very top of the food chain, predatory on all others, rapidly destroying their habitats, and diminishing the genetic diversity of domesticated species. Carnivores that once terrorized human bands have been all but exterminated. Rodents abound and threaten some food stores, but they can be contained with concrete and warfarin. Our agricultural surpluses are nibbled by insects; but at their worst, swarms of locusts will be regional, not global, pests. Barring genosuicide, the human dominion is challenged only by the pathogenic microbes, the predator for whom we remain the prey.

Our task is then to foresee the future of this coevolutionary relationship, our habitation of earth in company with large cohorts of microbes. We can discern conflicting trends. Within the infected host, the selective pressures favor aggressive growth correlated with lethality. Endogenous somatic cells are also potentially in mutual competition as well, but this competition is tempered by the evolutionary tradition that has resulted in the multicellular organism. The invaders are bereft of that tradition. But the host rapidly destroyed is a Pyrrhic victory for the parasite, so efficient transmissibility from host to host is correlated with delayed mortality. Our most effective parasites have entered into our own genome: every human carries these integrated retroviruses and is hardly aware of them, even of their possible symbiotic benefits.

The future of this relationship is incalculable. At the extreme, the global extermination of our species by disease is hypothetically possible, most likely in concurrence with the stresses of war and famine. But we need not search far for historic precedents of continental decimation of many plant and animal species and once every century or so of the human. At stake is a level of sickness and death manyfold higher than that caused by the highly publicized accidents of industrial pollution. Yet we continue to neglect the most elementary precautions.

We have had one wonderful success in the global eradication of smallpox. More problematically, we might accomplish close to the same with polio and perhaps a few other viral diseases. We certainly cannot aspire to decontaminate the earth with respect to all potential microbial rivals. These heroic projects deserve our attention, but in keeping with renewed vigilance and a stockpile of knowledge and developmental capacity to cope with an unpredictable variety of emergent pathogens.

Our most important need is a well-informed consciousness about these contingencies. Research workers at the front line will add more than any top-down line of command in the generation of new insights. And for operational programs of surveillance and of immunization, the working authorities will do better at designing what is feasible than outside consultants. But none of this will happen without a well-informed, internalized scientific and moral perspective and public understanding and political leadership to allocate the resources needed.